Non-invasive follow up of evolution of myocarditis with magnetocardiography

R. Agrawal, K. Czerski, P. Goedde, and U. Kuehl

Department of Cardiology and Pulmology, University Clinic Benjamin Franklin, Free University Berlin, D-12200 Berlin, Germany

1 Introduction

Especially for the prognosis of the patient it is important to monitor and follow-up the evolution of myocarditis with non-invasive yet fast and reproducible methods. To date only with endomyocardial biopsies can one reliably monitor the development of myocardial inflammation. The diagnosis of myocarditis is based on histological [1] and immunohistological [2] criteria defined by the presence of inflammatory cellular infiltration and myocardial necrosis. Due to the focal nature of the disease, the diagnostic techniques are hampered thus requiring multiple biopsies. Electrophysiological changes in the heart are known to be early markers for conduction disturbences in several heart diseases including myocarditis [3]. Magnetocardiography (MCG) shows promising results and could be used to identify early conduction disturbences in this patient group.

2 Materials and Methods

Thirty five healthy volunteers and thirty five patients with suspected inflammatory heart disease were included. From all the patients right ventricular endomyocardial biopsy specimens were obtained. Of the investigated patients, nine fulfilled the immunohistological criteria for the presence of inflammation in the myocardium. Though all patients received a magnetocardiographic mapping initially, the nine with inflammation were also investigated after 3-6 months, before the control biopsy was performed. As described elsewhere, the mapping was performed over a hundred consecutive heart beats with a 49 channel first order gradiometer at a sampling rate of 1 kHz. Signals were analyzed by magnetocardiographic spatio-temporal turbulence-analysis [4,5] with regard to beat-to-beat variability. One parameter of the analysis is electrical circulation (EC). This parameter describes the correlation between the instantaneous current dipole and its localization in consecutive heart beats.

3 Results

The control group had a EC value of < 1.0, while in the patient group the mean EC value was 4.2 ± 1.7 (representative tracing in Fig 2). This value decreased in 7 of 9 patients to a mean of 1.5 ± 0.5 in the follow-up. The CD3 cell count/high power field (CD3/HPF) in the first myocardial biopsy in these patients had a mean of 3.5 ± 1.0 as expression of lymphocytic infiltration. In the control biopsy the mean CD3/HPF was 1.8 ± 0.5. The correlation between change of CD3/HPF and EC value in each of the six patients was highly significant, with a r value of 0.77 (Fig. 1) and a p value of < 0.002. There was a parallel decrease of CD3/HPF and EC values. In 2 of 9 patients with a persisting lymphocytic infiltration and persistent CD3/HPF, the EC value did also not change significantly.

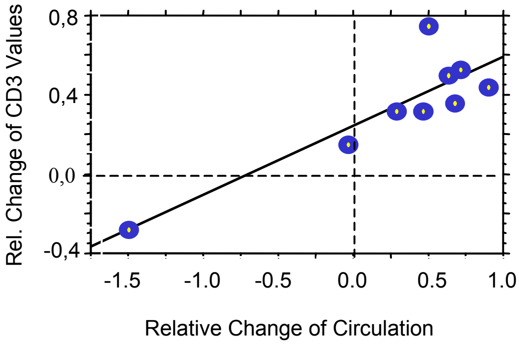

Figure 1: *Correlation between the relative change of the EC and CD3 values (r^2=0.77, ANOVA-test p=0.002)*

4 Discussion

The diagnosis and follow up of patients with persistent inflammatory heart disease is very important due to the poor prognosis of this patient group. Though the histological and immunohistological evaluation of myocardial biopsies are considered the gold standard for diagnosis and evolution, due to the invasive nature, the procedure can not be conducted universally and indiscriminately.

This study investigated with the help of high resolution magnetocardiographic mapping, a non-invasive method for mapping the magnetic flows on the body surface. This is a promising technique, with a very good signal to noise ratio, allowing detection of even the slightest changes in the magnetic and therefore electrical field.

Our study shows that there is a strong relationship between the electrical circulation and lyphocytic infiltration obtained through endomyocardial biopsies, regardless of the evolution. Patients with a resolving or persisting cardiac inflammation showed concimmitant results in the magnetocardiographic study. The decrease of our magnetocardiographic parameter, electrical circulation, goes hand in hand with a decrease of lymphocytic infiltration in the myocardial biopsy. In patients with no significant immunohistological change in the biopsy, there was likewise no significant change in the magnetocardiographic parameter. We believe a possible explanation for the increase in beat to beat variability could be an altered gap junction expression. Gap junction distribution is known to be markedly changed between cardiac myocytes in cardiomyopathies. Further studies need to underline this hypothesis.

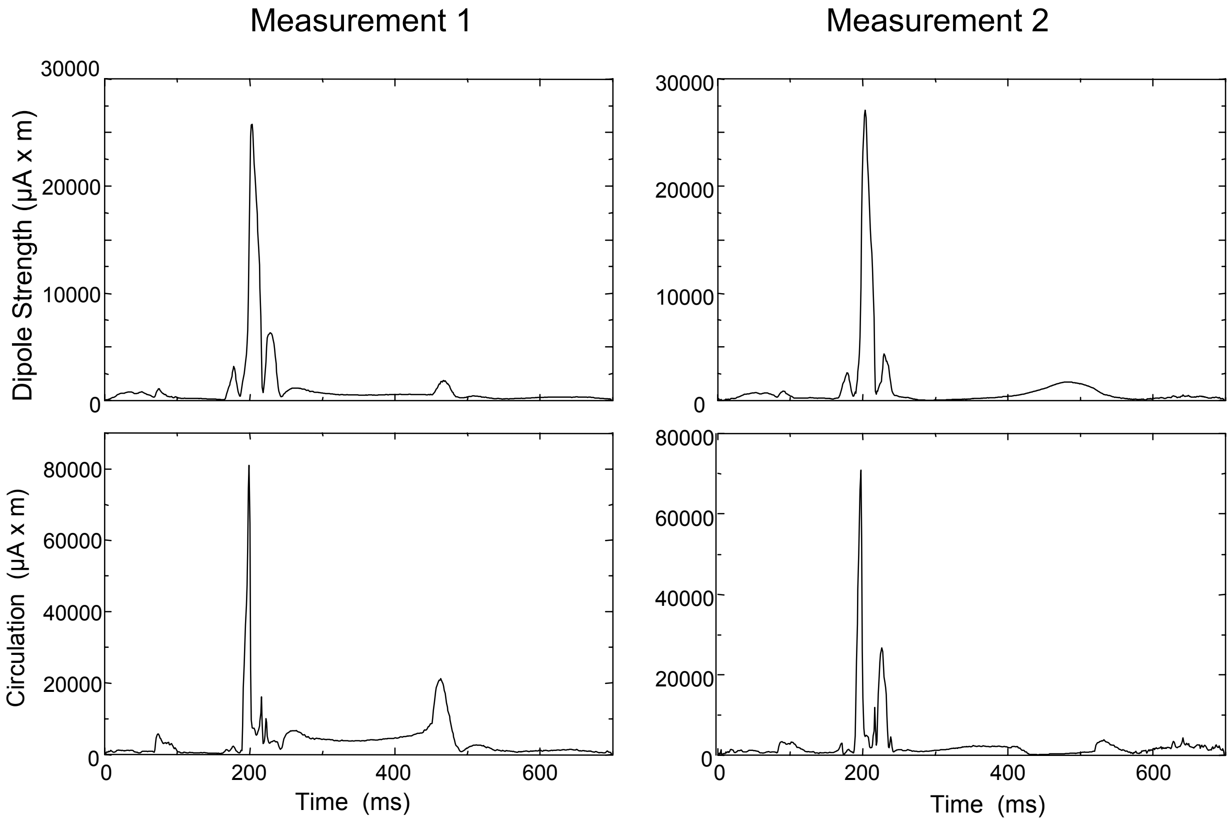

Figure 2: *Tracing of the mean current dipole (above) and electrical Circulation (below) over the entire heart cycle. In the tracing of the current dipole the P-wave, QRS-complex and T-wave can be seen. Left: A patient with inflammation of the heart. EC=8.5, CD34.1; Right: The same patient after three months with a significant improvement and decrease of inflammation EC=5.5, CD3= 2.8.*

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